In the United States Patent and Trademark Office

Serial No. _____

Appn. Filed : _____

Applicant: Yuri Glukhoy

Appn. Title: IONIZATION DEVICE FOR AEROSOL MASS SPECTROMETER AND METHOD OF IONIZATION

Examiner/GAU: _____

Mailed: Feb. 18/04

At: San Carlos, CA

Information Disclosure Statement

Commissioner for Patents

P.O. Box 1450, Alexandria, VA 22313-1450

Sir:

"Industrial Plasma Engineering" by Reece Roth, Vol. 1, Institute of Physics Publishing, Bristol and Philadelphia, 1992, pp. 206-218, sources of charged particles suitable for use in mass spectrometers.

US Patent No. 5,396,065 issued in 1995 to C. Myerholtz, et al. discloses an encoded sequence of charged-particles in packets for use in time-of-flight mass spectrometers, in which the high-mass charged particles of a leading packet will be passed by the low-mass charged particles of a trailing packet. However, the method and apparatus of the aforementioned patent make interpretation of obtained data more complicated and not easily comprehensible. Furthermore, addition electronic circuits are required for control of the charged particle packet sequence.

US Patent No. 5,753,909 issued in 1998 to M. Park et al. describes a method and apparatus for analyzing charged particles by determining times of flight including using a collision cell to activate charged particles toward fragmentation and a deflector to direct charged particles away from their otherwise intended or parallel course. A disadvantage of this device consists in that it is based on the selection of specific charged particles and does not show the entire mass spectrum. For obtaining the entire spectrum, it is necessary to perform step by step scanning, and this requires an additional time.

US Patent No. 6107,625 issued in 2000 to M. Park discloses a coaxial multiple reflection time-of-flight mass spectrometer of a time-of-flight type with resolution capacity improved due to a longer time of flight of the charged particles. The apparatus comprises two or more electrostatic reflectors positioned coaxially with respect to one another such that charged particles generated by a charged-particle source can be reflected back and forth between them. This system with storage of charged particles does not allow a continuous mode of mass analysis. The data is difficult to interpret, especially when masses of charged particles are scattered in a wide range.

U.S. Patent Application No. 10/058,153 field by Yu. Glukhoy on January 29, 2003 discloses a quadrupole mass spectrometer that provides extended time of flight trajectory and hence a very high the time resolution. A mass spectrometer of the aforementioned patent application is based on the use of quadrupole lenses with an angular gradient of the electrostatic field from lens to lens. The charged particles perform flights in direct and reverse directions along helical trajectories. However, the above-described helical-path quadrupole mass spectrometer, as well as all aforementioned known mass spectrometers of other types, is not very convenient for aerosol applications and is not suitable for operation in a continuous mode.

Different methods used for reconstruction of the particle distribution spectra in acquisition period of the cycle of mass spectrometer are described in the following literature sources: 1) G. Wilhelmi, et al. in "Binary Sequences and Error Analysis for Pseudo-Statistical Neutron Modulators with Different Duty Cycles," Nuclear Inst. and Methods, 81 (1970), pp. 36-44; 2) Myerholtz, et al. " Sequencing ion packets for ion time-of-flight mass spectrometry" (see aforementioned US Patent 5,396,065 described earlier in the description of the prior art); 3) Cocg "High duty cycle pseudo-noise modulated time-of-flight mass spectrometry" (US Patent 6,198,096, issued March 6, 2001; 4) Brock, et al. "Time-of-flight mass spectrometer and ion analysis" (US Patent 6, 300,626, issued October 9, 2001); 5) Overney, et al. "Deconvolution method and apparatus for analyzing compounds" (US Patent 6,524,803, issued February 25, 2003), etc. The above methods utilize special properties of the pulsing sequence, e.g., a pseudo-random binary sequence (PRBS) or Hadamard Transform. However, they cannot reach a high duty-cycle because their TOF MS's annihilate a part of the flow of charged particles by a gating grid [see references 3) and 4)] or deflecting mesh [see reference 5)] during binary modulation that they converted. This is because at least a half of the charged-particle flow must be discarded to allow the other half to be counted. The flow of charged particles sputters and contaminates the modulation grids or meshes and creates secondary electron-, ion-, or photon-emission leading to deterioration of the grids. Furthermore, foreign species introduced in the drift space because of contamination and sputtering destruct the detectors and distort the information. The low sensitive flat deflection system, which is used in the in the A.Brock et al TOF-MS for the Hadamard's transform, contains a high density array of the wires with alternating potential that leads to breakdown.

A large group of ionizers used in mass spectrometers is based on a principle according to which a substance to analyzed is first converted into plasma, which in ionization is used as a source of ions. The ionizers of this group are described in great detail in Chapter 6 of "Industrial Plasma Engineering" by J. Reece Roth, Institute of Physics Publishing, 1995. The ionizers that constitute this group differ from each other mainly by mechanisms used for igniting and sustaining plasma of gas discharge as well as by methods used for extracting ions from the plasma volume. However, ionizers contained in this gas discharge or plasma type group are not applicable for aerosol mass spectrometers.

U.S. Patent No. 5,756,996 issued in 1998 to Mark Bier, et al. discloses an external ion source assembly in which ions are formed in an ion volume by the interaction of energetic electrons and gas molecules. U.S. Patent No. 5,825,025 issued in 1998 to Eric Kerly discloses a miniaturized time-of-flight mass spectrometer having a minimized flight path of sample ions between a repeller and a detector in order to minimize the overall size of the time-of-flight mass spectrometer (TOF-MS), thereby requiring a reduced vacuum capacity. U.S. Patent No. 5,907,154 issued in 1999 to Manabu Shimomura describes an ionization in which a level of contamination inside the ionization chamber is estimated by monitoring the output of the detector. The device of this patent is a good example of an ionizer equipped with means for preventing admission of non-charged particles (contaminants) into the mass spectrometer. U.S. Patent No. 6271527 issued in 2001 to Ara Chutjian discloses an improved electron ionizer for use in a quadrupole mass spectrometer. A common disadvantage of all these known ionization devices is that they are not applicable for use in an aerosol mass spectrometer operating in real time and either do not allow control of the residence time of particles while they are ionized in the ionization device, or destroy multimolecular particles which are to be analyzed. If the residence time of the particles in the ionization device is not controlled, heavy particles that

possess large masses may be subjected to multiple charging. This will create problems for identification of particles by masses. On the other hand, defragmentation of large particles also makes identification of particles by mass more complicated and unacceptable, especially in analysis of particles of a chemical and biological nature.

Thus, none of the references mentioned above discloses, as claimed in my independent Claim 1 with dependent Claims 2-9 and in my independent Claim 10 with dependent Claims 11-25, an ionization device which is suitable for use in an aerosol time-of-flight mass spectrometer that can operate in a continuous mode with a heavy-duty cycle and consists of a number of hollow concentric cylindrical bodies connected to voltage sources and functioning as electrodes that extract electrons from the hot filament of the electron gun and direct them onto the flow of particles for their ionization on their way to the aerosol TOF MS for analysis. Furthermore, none of the references mentioned above discloses, as claimed in my independent Claim 26 with dependent claims 27-33, a method of mass spectroscopy by ejecting the charged particles into the vacuum chamber of an aerosol time-of-flight mass spectrometer via a plurality of inlet openings for simultaneous and independent analysis of charged particles in different flows.

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

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Complete if Known	
Application Number	
Filing Date	
First Named Inventor	Yuri Glukhoy
Art Unit	
Examiner Name	
Attorney Docket Number	

U. S. PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Document Number Number-Kind Code[2] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
		US- 5,396,065	1995	Myerholtz et al.	
		US- 5,753,909	1998	M. Park et al.	
		US- 6,107,625	2000	M. Park	
		US- Pat. Appl. 10/158,153	Y. Glukhoy,	2003	
		US- 6,198,096	2001	Cucq	
		US- 6,300,626	2001	Brodt, et al	
		US- 6,524,803	2003	Overney, et al.	
		US-			
		US- 5756,996	1998	Bier, et al.	
		US- 5,825,025	1998	Kerly	
		US- 5,907,154	1999	Shimomura	
		US- 6,271,527	2001	Chutjian	
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FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Foreign Patent Document Country Code[3]-Number[4]-Kind Code[5] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T[6]

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

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Sheet | | of | |

Complete if Known	
Application Number	
Filing Date	
First Named Inventor	Yuri Glukhoy
Art Unit	
Examiner Name	
Attorney Docket Number	

NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No.[1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T[2]
—	—	Reece Roth: Vol. 1, Institute of Physics Publishing, Bristol and Philadelphia, 1992, pp. 206 - 218	
—		G. Wilhelmi, et al. "Binary Sequences and Error Analysis for Pseudo-Statistical Neutron Modulators with Different Duty Cycles", Nuclear Inst. and Methods, 81 (1970), pp. 36-44	
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